Space Weather Technical Forecast

Issued on Monday, 20 November 2023 at 13:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Increasing Chance of R1. Risk of G1, peaking Tuesday 21 Nov.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was moderate, with a single M1.27 flare at 20/0903 UTC, emanating from AR3490. There are currently six sunspot groups on the disc, all of which are in the eastern solar hemisphere. Three of these are unnumbered and have recently rotated onto the visible disk or have emerged. AR3489, in the southeast, showed further proliferation and movement in its central spots, now with delta region, though considered tenuous. By far the largest group is AR3490 in the northeast, which sparsely occupies a large plage in both latitude and longitude. Proliferation of spots continued in it's central portion, this accompanied by increased clarity as it rotated further onto the visible disk.

Numerous filament and prominence eruptions were apparent on coronagraph imagery in the period, although the vast majority appeared far-sided or else emanated from the limbs, with none expected to be Earth directed.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by ACE and DSCOVR at L1, have followed a varying slow regime in the past 24 hours, with hints of a very weak transient late in the period. The solar wind speed fell slightly from 360m/s to around 310 Km/s. The solar wind density rose from background to moderate levels, peaking 27 ppcc at 20/1047 UTC. The IMF was followed a similar trend, rising later in the period, peaking at moderate levels, 14nT, at 20/1003 UTC, though the north-south component of the IMF, Bz, remained weak, varying between +7/-5nT with an erratic character. Finally, the phi angle was mainly negative (towards the Sun) almost entirely throughout. The net result of the above solar wind measures was for Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at Background levels.

GOES16 high energy (greater than 2MeV) electron flux ranged from Normal Background to Moderate levels, with a peak of 250pfu at 19/1525UTC. The associated 24-hour fluence has declined slightly and remains below the Active threshold (1e8 integrated pfu). The fluence observation at 20/0001UTC was 5.89e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a daily Chance of M-class flares from current eastern solar horizon sunspot regions, perhaps rising slightly as a result of a further arrival over the eastern limb.

Solar Wind / Geomagnetic Activity: There is one CME in the current forecast - the central filament eruption from 16/0100UTC. Solar wind parameters indicate an imminent arrival, bringing a Slight Chance of a G1/Minor Geomagnetic Storm today (20 Nov). Activity is expected to otherwise be mostly Quiet to Unsettled until the anticipated onset of a coronal hole HSS on Tuesday or Wednesday (21/22 Nov), which may see a slightly greater Chance of generating a G1/Minor Geomagnetic Storm should it arrive on Tuesday.

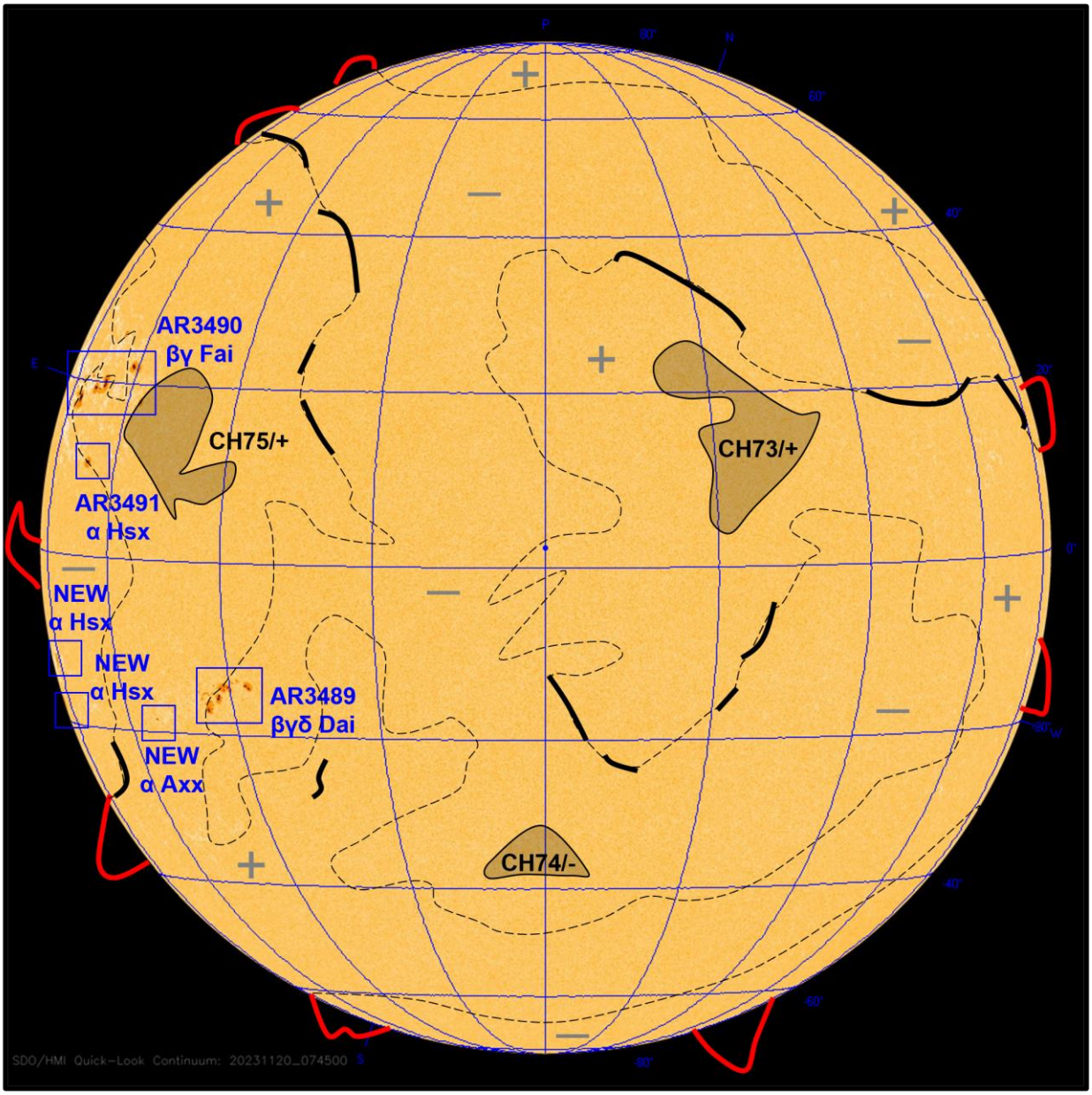
Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Energetic Particles / Solar Radiation: GOES16 high energy proton flux is expected to remain at Background levels.

GOES16 high energy electron flux is expected to continue to peak at Moderate levels at first, before the potential CME arrival and associated geomagnetic activity suppresses counts at GEO. This suppression may continue with CH73 until midweek, before an eventual late-week increase once this fast wind's geomagnetic activity lessens. The associated 24-hour electron fluence will most likely remain below the Active (1e8 integrated pfu) level in this four-day period, but with a probable increasing trend into the tail end of the UTC working week.

Figure 1. Solar Analysis Valid 20/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Geomagnetic Storms:

There is one Earth-directed CME that features in the current forecast, the 16/0100 UTC filament eruption from near centre-disc. Despite extensive analyses, the onset time of this feature remains low confidence, although confidence as to a portion of the ejecta lying on the Sun-Earth line is much higher. We remain in a feasible time window for the arrival of the 16/0100UTC CME, with potential early indications of a signal at L1 though no enhancement of ACE EPAM LEMS. Arrival is still considered most likely during Monday 20 November. No new Earth-directed CMEs were observed over the UTC weekend.

The coronal hole-based forecast now comprises just CH73/+, a clear feature currently lying close to the solar equator narrowly in the western hemisphere which is likely to affect Earth Tuesday or Wednesday UTC. On the previous rotation, this feature was at a similar longitude and produced winds of around 450-500 km/s. This feature is now visually darker and more pronounced on AIA211, and a faster emanating wind is therefore inferred of around 500km/s.

In terms of other potential sources of geomagnetic activity in the forecast that are not yet quantified in the percentages, much of the CME activity seen on available coronagraph imagery over the past 24 hours has been tied to the eastern solar horizon. This is likely to play an increasing role in the risk of geomagnetic activity through the period should activity persist. In addition to this, there are a number of filaments on the disc which have the potential to disrupt and lift-off, perhaps producing Earth-directed CMEs, although there is nothing to imply this is imminent or in progress at the time of writing.

Overall, the geomagnetic forecast comprises a slight chance of G1 today and Wednesday UTC with a chance on Tuesday, firstly from the CME within day one, Monday 20 November with a tail into Tuesday; and then an arriving fast wind Tuesday or Wednesday.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

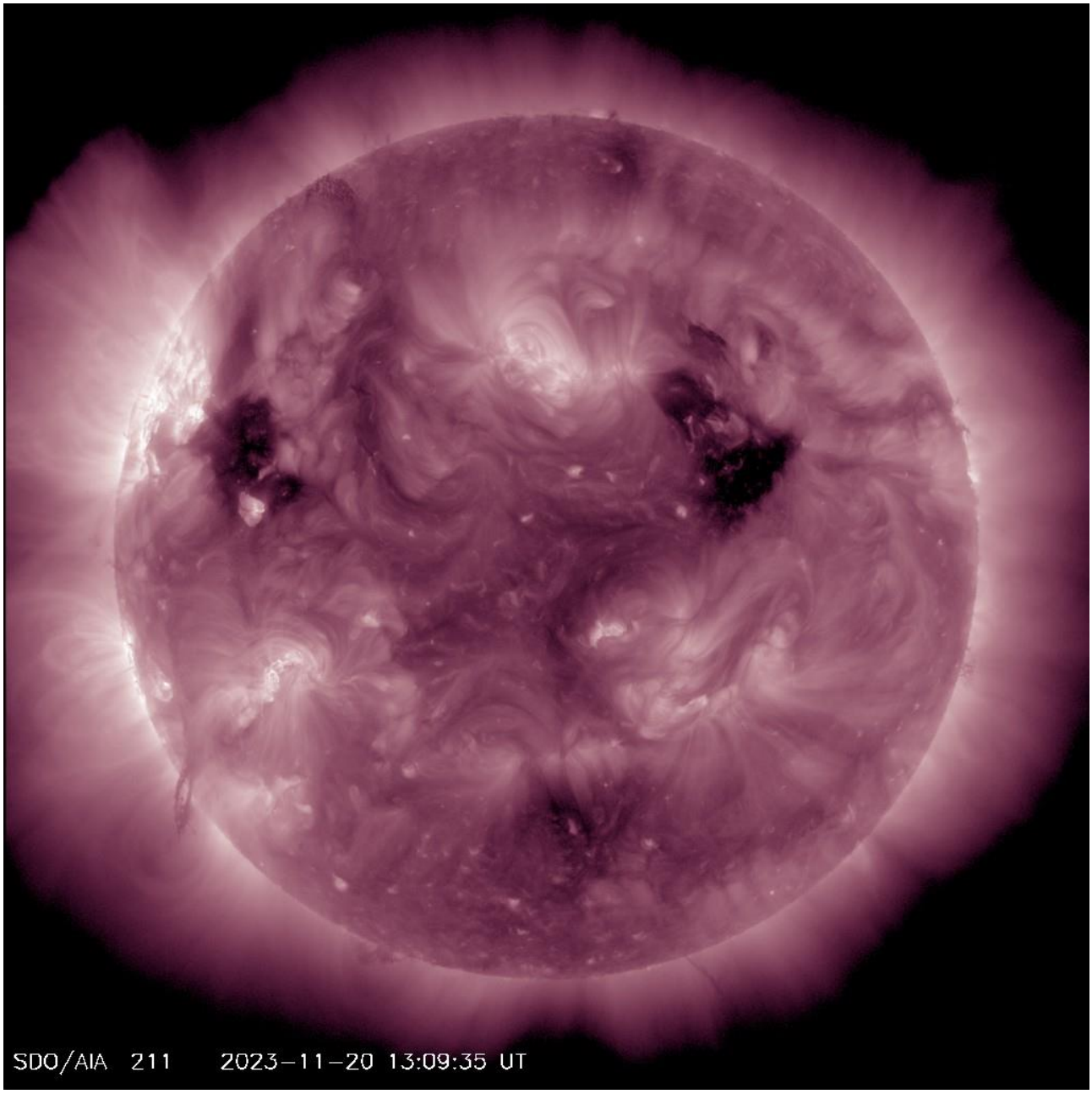
Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
16/1100	Partial	Filament Eruption	NW Central	400 km/s	20/0600 UTC +/- 12 hrs	Low confidence, may have already arrived with no particular geomag response.

Figure 2: SDO 211 imagery showing CH73.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Space Weather Technical Forecast



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

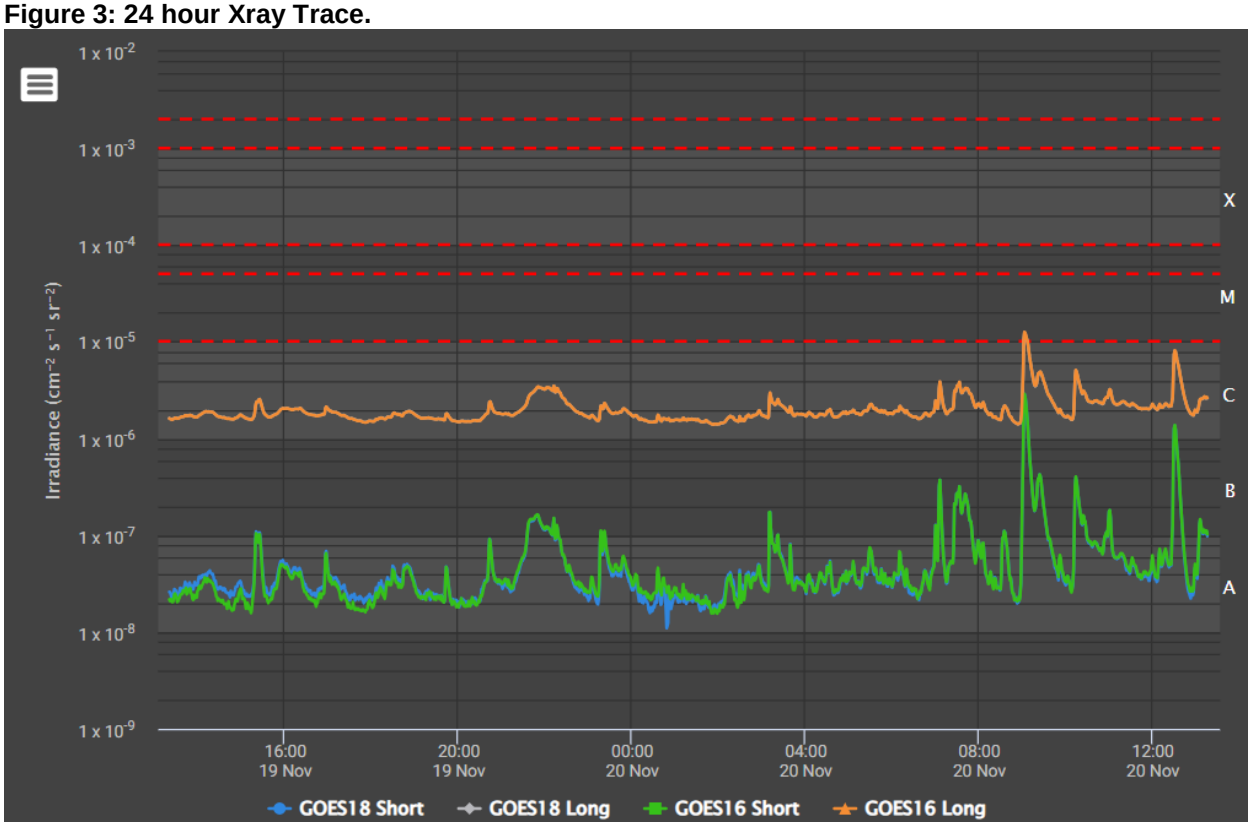
Radio Blackouts - X-Ray Flares:

There are currently six sunspot groups on the disc, all of which are in the eastern solar hemisphere. Three of these are unnumbered and have recently rotated onto the visible disk or have emerged. AR3489, in the southeast, showed further proliferation and movement in its central spots, now with delta region, though considered tenuous. By far the largest group is AR3490 in the northeast, which sparsely occupies a large plage in both latitude and longitude. Proliferation of spots continued in it's central portion, this accompanied by increased clarity as it rotated further onto the visible disk. All other spots are small and simple at present, with a NEW small region emerging behind AR3489 and two NEW spots emerging on the southeast limb.

All considered, there is a rising Chance of M-class flares given the complex eastern solar horizon and the potential for still more regions arriving here in the first half of the UTC working week. X-class flares are now also considered a daily Slight Chance given the potential in AR3490 in particular.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	40	50	50	50
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: 24 hour Xray Trace.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at Background levels.

The arrival of one of potentially several large and complex region over the eastern solar horizon over the coming days has resulted in an above background risk of a S1/Minor Solar Radiation Storm. This risk remains nominal until any significant groups approach the western solar hemisphere. There are no significant off-going regions offering any diminishing contribution to this risk.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

Electron flux levels are expected to continue in a similar vein to the UTC weekend at first, having likely reached a steady state in varying between Normal Background and Moderate flux levels. Following the arrival of the 16/0100UTC CME, flux levels at GEO may be briefly suppressed, with this effect probably sustained by any fast wind from CH73, before a late-week (UTC) increase to a peak Chance of Active fluence.

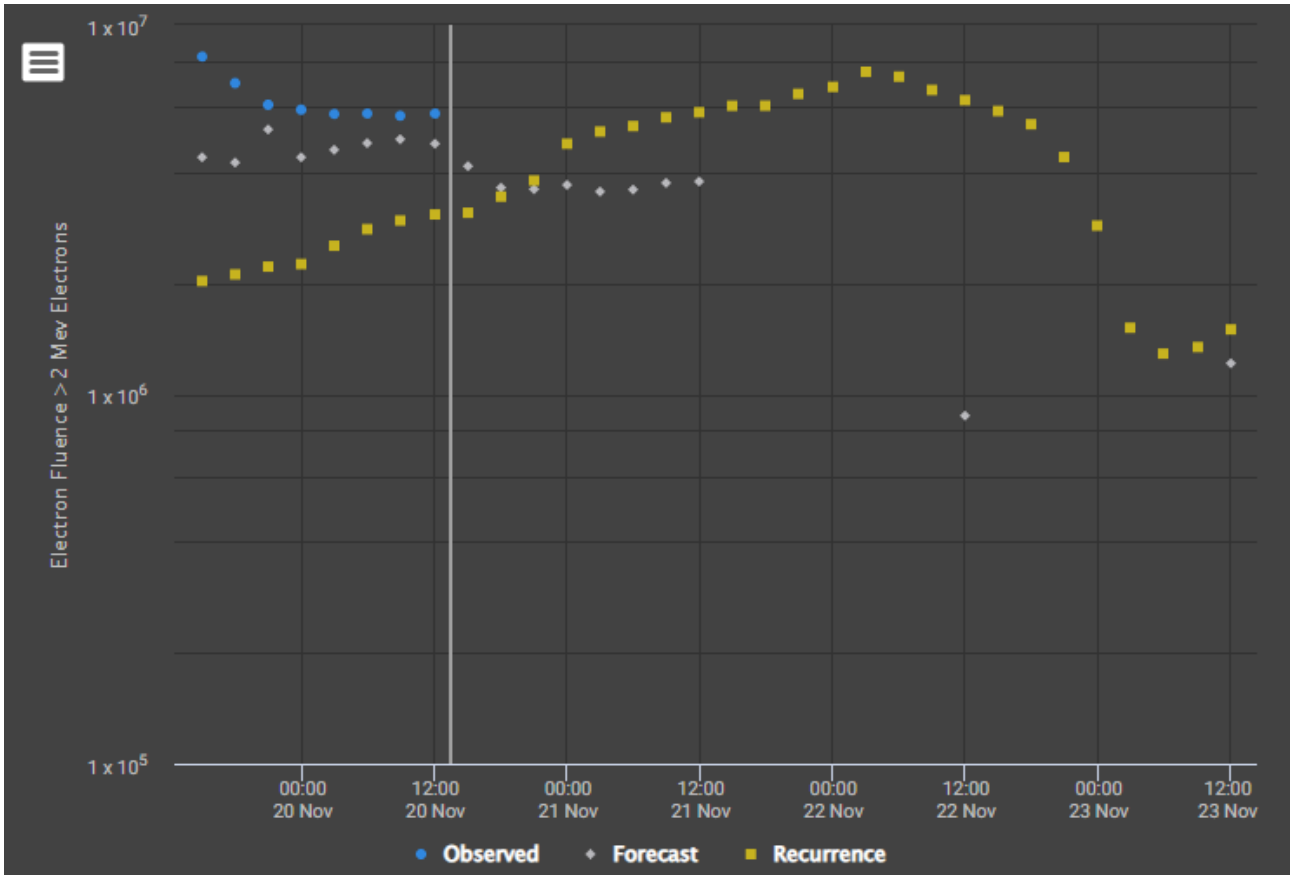
The onset of the 16/0100UTC CME early in the four-day forecast period is likely to render REFM ineffective as a forecast tool for a time, although its utility should increase significantly as the week progresses.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	10	30
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.

Figure 4: REFM model showing electron fluence.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2023. All Rights Reserved.